

Claims

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- 3 *sub A* 1. An apparatus including a mass storage device, said mass storage device
- 4 having a plurality of sectors, said apparatus including
- 5 a plurality of storage blocks, each said storage block including a plurality of
- 6 said sectors;
- 7 wherein each said storage block includes a data portion and an error code
- 8 portion;
- 9 wherein said data portion is responsive to data for said data block; and
- 10 wherein said error code portion is responsive to data for a plurality of said
- 11 sectors in each said storage block.
- 12
- 13 2. An apparatus as in claim 1, wherein said mass storage device includes
- 14 one or more hard disks.
- 15
- 16 3. An apparatus as in claim 1, wherein said mass storage device includes a
- 17 RAID storage device.
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- 19 4. An apparatus as in claim 3, wherein said RAID storage device is a
- 20 RAID level 4 device.

1 5. An apparatus as in claim 1, wherein said error code portion is appended
2 to said data portion.

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4 6. An apparatus as in claim 1, wherein said error code portion includes a
5 checksum of the said data for said data block.

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7 7. An apparatus as in claim 6, wherein said checksum of said data for said
8 data block includes 4-bytes of checksum data.

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10 8. An apparatus as in claim 6, wherein said checksum is a block-appended
11 checksum.

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13 9. An apparatus as in claim 8, wherein said block-appended checksum
14 includes a checksum of said block-appended checksum.

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16 10. An apparatus as in claim 9, wherein said checksum of said block-
17 appended checksum includes 4-bytes of data.

18
19 11. An apparatus as in claim 1, wherein said mass storage device includes a
20 cache or RAM.

12. An apparatus as in claim 1, wherein said mass storage device includes one or more hard disks formatted with 520-bytes per sector.

13. An apparatus as in claim 1, wherein said plurality of said sectors is eight sectors.

14. An apparatus as in claim 1, wherein said error code portion includes 64-bytes of error code data.

15. An apparatus as in claim 1, wherein said data portion includes 4,096-bytes of data.

16. An apparatus as in claim 1, wherein said sectors include 520-bytes of data storage.

17. An apparatus as in claim 1, wherein said storage block includes 4,160-bytes of data and error code storage space.

18. An apparatus for protecting a mass storage device from data storage errors, said mass storage device having a plurality of sectors, said apparatus including

1 a plurality of storage blocks, each said storage block including a plurality of

2 said sectors;

3 wherein a first subset of each said storage block is responsive to data for said

4 storage block;

5 wherein a second subset of each said storage blocks is responsive to error code

6 information; and

7 wherein said error code information is responsive to data for a plurality of said

8 sectors in each said storage block.

9
10 19. An apparatus as in claim 18, wherein said mass storage device includes

11 one or more hard disks.

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13 20. An apparatus as in claim 18, wherein said mass storage device includes

14 a RAID storage system.

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16 21. An apparatus as in claim 20, wherein said RAID storage system is a

17 RAID level 4 system.

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19 22. An apparatus as in claim 18, wherein said second subset is appended to

20 said first subset.

1 23. An apparatus as in claim 18, wherein said error code information
2 includes a checksum of said data for said storage block.

3
4 24. An apparatus as in claim 23, wherein said checksum of said data for
5 said storage block includes 4-bytes of checksum data.

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7 25. An apparatus as in claim 23, wherein said checksum is a block-
8 appended checksum.

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10 26. An apparatus as in claim 25, wherein said block-appended checksum
11 includes a checksum of said block-appended checksum.

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13 27. An apparatus as in claim 26 wherein said checksum of said block-
14 appended checksum includes 4-bytes of data.

15
16 28. An apparatus as in claim 18 wherein said mass storage device includes a
17 cache or RAM.

18
19 29. An apparatus as in claim 18 wherein said mass storage device includes
20 one or more hard disks formatted with 520-bytes per sector.

1 30. An apparatus as in claim 18, wherein said plurality of said sectors is
2 eight sectors.

3
4 31. An apparatus as in claim 18, wherein said second subset includes 64-
5 bytes of error code data.

6
7 32. An apparatus as in claim 18, wherein said first subset includes 4,096-
8 bytes of data.

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10 33. An apparatus as in claim 18, wherein said sectors include 520-bytes of
11 data storage.

12
13 34. An apparatus as in claim 18, wherein said first and second subsets
14 together include 4,160-bytes of data and error code storage space.

15
16 35. A method for protecting data from data storage errors in a mass storage
17 system, said mass storage system having a plurality of sectors, said method including
18 determining a plurality of storage blocks, each said storage block including a
19 plurality of said sectors;
20 dividing each said storage block into a first subset and a second subset;

1 generating error code information responsive to data for a plurality of said

2 sectors in each said storage block;

3 wherein said first subset is responsive to data for said storage block; and

4 wherein said second subset is responsive to error code information.

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6 36. A method as in claim 35, wherein said mass storage system includes

7 one or more hard disks.

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9 37. A method as in claim 35, wherein said mass storage system includes a

10 RAID storage system.

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12 38. A method as in claim 37, wherein said RAID storage system is a RAID

13 level 4 system.

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15 39. A method as in claim 35, wherein said second subset is appended to said

16 first subset.

17
18 40. A method as in claim 35, wherein said error code information includes a

19 checksum of the said data for said storage block.

1 41. A method as in claim 40, wherein said checksum of said data for said
2 storage block includes 4-bytes of checksum data.

3
4 42. A method as in claim 40, wherein said checksum is a block-appended
5 checksum.

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7 43. A method as in claim 42, wherein said block-appended checksum
8 includes a checksum of said block-appended checksum.

9
10 44. A method as in claim 43, wherein said checksum of said block-
11 appended checksum includes 4-bytes of data.

12
13 45. A method as in claim 35, wherein said mass storage system includes a
14 cache or RAM.

15
16 46. A method as in claim 35, wherein said mass storage system includes
17 one or more hard disks formatted with 520-bytes per sector.

18
19 47. A method as in claim 35, wherein said plurality of said sectors is eight
20 sectors.

1 48. A method as in claim 35, wherein said second subset includes 64-bytes
2 of error code data.

3
4 49. A method as in claim 35, wherein said first subset includes 4,096-bytes
5 of data.

6
7 50. A method as in claim 35, wherein said sectors include 520-bytes of data
8 of storage.

9
10 51. A method as in claim 35, wherein said first and second subsets together
11 include 4,160-bytes of data and error code storage space.

12
13 52. A method for efficiently detecting data errors in a mass storage system,
14 said mass storage system having a plurality of storage blocks composed of a collection of
15 sectors, including

16 reading data and error code information located in said storage blocks in a
17 single operation;

18 calculating run-time error code information for said data located in storage
19 blocks; and

20 comparing said error code information with said run-time error code

1 information.

2
3 53. A method as in claim 52, wherein said mass storage system includes one
4 or more hard disks.

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6 54. A method as in claim 52, wherein said mass storage system includes a
7 RAID storage system.

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9 55. A method as in claim 52, wherein said RAID system is a RAID level 4
10 system.

11
12 56. A method as in claim 52, wherein said error code information is
13 appended to said reading data.

14
15 57. A method as in claim 52, wherein said error code information includes a
16 checksum of the said reading data.

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18 58. A method as in claim 57, wherein said checksum of said reading data
19 includes 4-bytes of checksum data.

1 59. A method as in claim 58, wherein said checksum is a block-appended
2 checksum.

3
4 60. A method as in claim 59, wherein said block-appended checksum
5 includes a checksum of said block-appended checksum.

6
7 61. A method as in claim 60, wherein said checksum of said block-
8 appended checksum includes 4-bytes of data.

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10 62. A method as in claim 52, wherein said mass storage system includes a
11 cache or RAM.

12
13 63. A method as in claim 52, wherein said mass storage system includes
14 one or more hard disks formatted with 520-bytes per sector.

15
16 64. A method as in claim 52, wherein said collection of sectors is eight
17 sectors.

18
19 65. A method as in claim 52, wherein said error code information includes
20 64-bytes of error code data.

1 66. A method as in claim 52, wherein said reading data includes 4,096-bytes
2 of data.

3
4 67. A method as in claim 52, wherein said sectors include 520-bytes of data
5 storage.

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7 68. A method as in claim 52, wherein said reading data and error code
8 information together includes 4,160-bytes of data and error code storage space.

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10 69. A method as in claim 52, including determining whether said run-time
11 error code information and said error code information in said storage blocks are equivalent.

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13 70. A method as in claim 52, including alerting said mass storage system if
14 said run-time error code information and said error code information in said storage blocks
15 are not equivalent.

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17 71. A method as in claim 52, including retrieving said reading data if said
18 run-time error code information and said error code information in said storage blocks are
19 equivalent.